# UOFK PETRO MAGAZINE


## THE MOST ABUNDANT ELEMENT IN THE UNIVERSE THAT COULD FACILITATES ENERGY TRANSITION EFFICIENTLY

### ALSO FEATURING:

- FUELING GROWTH: HOW OIL SHAPES THE MODERN ECONOMY
- BEYOND THE FLAMES: THE HIDDEN COST OF GAS FLARING
- INSIDE THE RESERVOIR: SIMULATION POWERING THE FUTURE OF ENERGY

SPE UNIVERSITY OF KHARTOUM STUDENT CHAPTER
4TH EDITION

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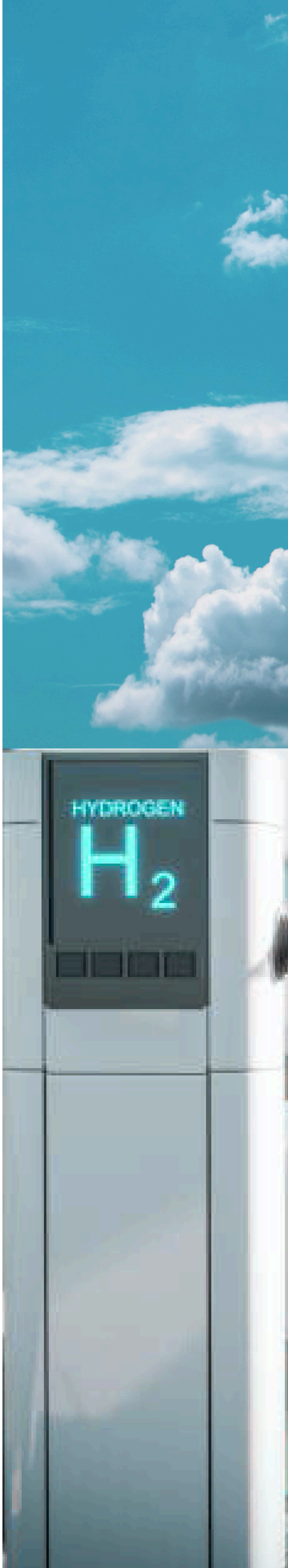
# CONTENT TABLE



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# THE ECONOMY AND THE OIL PRODUCING COUNTRIES


The meaning of the word *"economy"* actually came from the combination of two Greek words, 'Oikos' which means household, and 'Nemein' which stands for manage. In simple words, the economy illustrates the state of a country with reference to its production, distribution, and trade as well as consumption of goods.

There are many types of Economies, below are the main types:

## 1. Socialist Economy

When all the entities and means of production through farms and factories are socialized and quintessentially belong to the country (no individual owners). like Russia USSR.

## 2. Capitalist Economy

It is the opposite of the past one. When the private sector plays a dominant role in controlling the economy. With the fall of the USSR, all the countries adopted this type of economy. Countries like Hong Kong, India, and UAE are some well-known capitalist economies as well.

## 3. Underdeveloped and Developed Economies

In this type of economy, agriculture is the main source of income, and rapid increase of population, underutilization of natural resources, low per capita income, lows tandard of living, uneconomic social structure, under-developed infrastructure, etc. While in developed economies the standard of living is robust and there is a higher capital formation.

## 4. Free-enterprise Economy

In this type of economy, there is a complete economic democracy. there is no central authority that could coordinate, guide as well as direct the economic activities. It is economic freedom, there is no control or restraints. The USA, and Singapore, are the best example of countries that follow the free-enterprise economy model.

## 5. Planned Economy

In this type of economy, a centrally planned authority plays a decisive role, no matter whether the economy is a capitalist or a socialist one. Communist, as well as socialist systems, are prime examples of planned economies.

## 6. Mixed Economy

This type of economy is a combination of private and governmental enterprises. it secures private property but then also allows economic freedom to a certain extent in the use of capital while permitting the government to run interference in economic practice to fulfill social objectives.

# The Oil Economy

From the term, it's obvious that an oil economy means when a country depends on the income of the exportation of oil to enhance the economy. Most of these Economies are Capitalist economies or Planned economies.
Despite the data showing the harmful effects of fossil fuels, most countries still depend on this energy source, and it often becomes the mainstay of their economy. I have transferred some examples of countries most dependent on oil from a list of 25 countries created by Stacker using information collected by the World Bank: Oil rents as a percentage of a country's GDP and fuel exports as a percentage of a country's merchandise exports.

## 1. Kuwait

Oil revenue as % of GDP (2016): 44.03%
Fuel exports as % of merchandise exports (2017): 89.69%
Petroleum is Kuwait's largest industry, making up almost half of its gross domestic product. The Kuwait Petroleum Company, a government-owned oil company, produces about 2.7 million barrels of oil a day. Kuwait was one of the five founding countries of the OPEC and remains a member today.

## 2. Iraq

Oil revenue as % of GDP (2016): 42.41%
Fuel exports as % of merchandise exports (2017): 99.99%
The earliest search for oil in the modern area of Iraq began under the Ottoman Empire in the 20th century. The United Nations estimates that 99% of Iraq's revenue comes from oil. With an estimated 50 to 200 billion barrels of oil still undiscovered, Iraq has the largest untapped market in the world.

## 3. Republic of the Congo

Oil revenue as % of GDP (2016): 19.42%
Fuel exports as % of merchandise exports (2014): 61.868%
Oil production began in the Republic of the Congo in the 1970s and is still expanding. President Denis Nguesso increased output to 350,000 barrels a day in 2018, a 25% growth over 2017. This is in contrast to some other African countries, which are decreasing production.

## 4. Sudan

Oil revenue as % of GDP (2016): 0.59%
Fuel exports as % of merchandise exports (2011): 90.862%

The oil economy countries face significant challenges, not only because of the instability in the price of oil but also because of the poor production diversity (no diversity in the types of products exported from the country) of most of these countries. Time has passed without enough effort to diversify, not only because of poor expectations but also because of neglect and preoccupation with other things, which may have diverted attention in the wrong directions. The significant challenges for the oil countries are: facing the current situation, financing budgets, and changing the structure of spending, as well as revenues. The challenges are significant because time is passing quickly, not only because of pressing economic factors but also because of the tense political situation in the entire region.

# GAS FLARING

## THE HIDDEN WASTE IN OIL PRODUCTION

In oil production systems, a massive amount of natural gas is often wasted during extraction. This happens when oil projects are planned without incorporating access to a gas market.

This practice is known as gas flaring, and it occurs for several reasons — including market and economic limitations, weak regulations, and a lack of political will.

### What Is Gas Flaring?

A gas flare or flare stack is a gas combustion device used in industrial facilities such as petroleum refineries and oil or gas extraction sites.

When natural gas is found within an oil reservoir, operators usually have only a few options:

1. Utilize the gas onsite — for example, by re-injecting it into the ground or using it for power generation.
2. Flare or vent the gas to the atmosphere — venting is even worse for the environment than flaring.

Most flaring today is known as routine flaring, which happens during normal oil production operations. However, flaring also occurs as a safety measure, such as when gas pressure builds up due to a sudden change in operating conditions.

### Environmental Impact

Flare gas often contains harmful substances such as hydrogen sulfide ($H_2S$), carbon dioxide ($CO_2$), and methane ($CH_4$).

The incomplete combustion of these gases releases large amounts of greenhouse gases (GHGs), especially methane, which significantly contributes to global warming and climate change.

This leads to environmental problems such as acid rain, which negatively affects agriculture and forests.

A shocking fact: each cubic meter of associated gas flared results in more than 400 million tons of $CO_2$ equivalent emissions annually.

### Reasons Behind Gas Flaring

Every year, around 144 billion cubic meters of gas are flared globally — an amount that could power all of Sub-Saharan Africa.

However, in some cases, flaring is still necessary:

1. Safety Reasons: Extracting and processing oil and gas involves extremely high and unstable pressures, which can cause explosions if not safely managed.
2. Economic Reasons: Some reservoirs do not produce consistent or large volumes of associated gas, making it uneconomical to capture and use the gas. In such cases, the gas is typically flared.

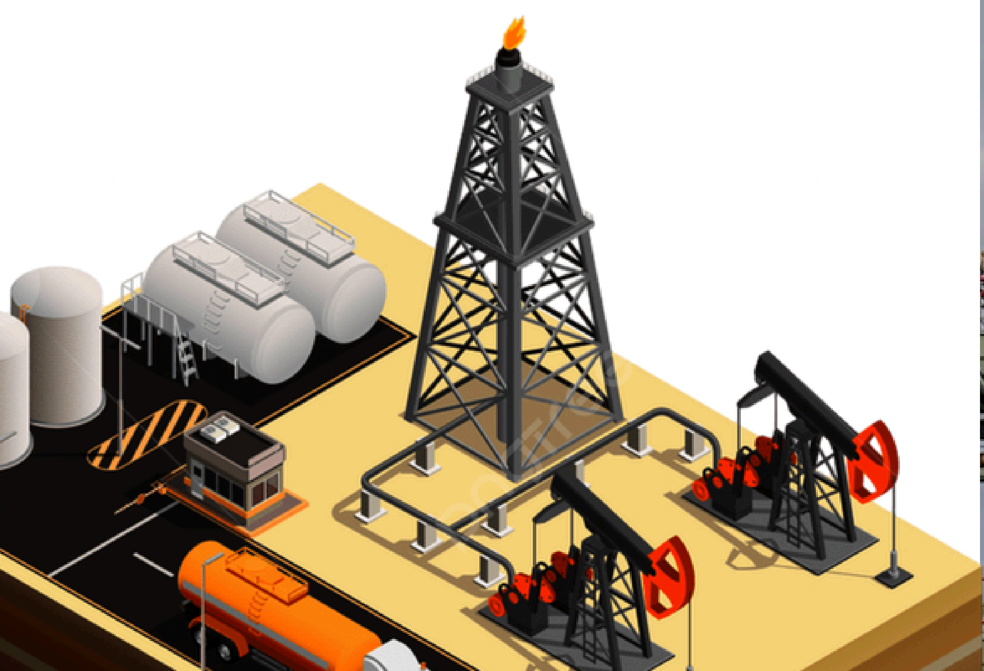
## Alternatives to Gas Flaring

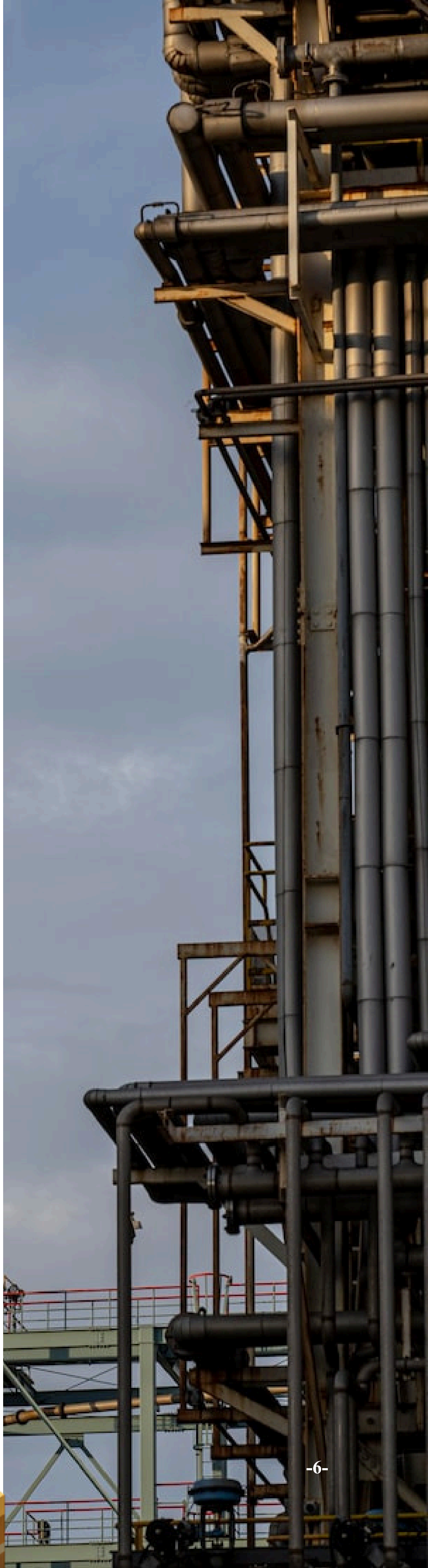
Fortunately, there are several economical and sustainable alternatives to flaring. These methods can reduce emissions while increasing energy efficiency:

- Flare Gas Power Generation: Recovered gas from oil wells can be used to generate electricity for local use or to supply nearby communities.
- Liquefied Natural Gas (LNG): Liquefying and storing associated gas makes it easier and safer to transport. LNG can be used for cooking, heating, and industrial purposes.
- Gas Reinjection in Secondary Oil Recovery: The recovered natural gas can be re-injected into aging wells to maintain pressure and enhance oil recovery.
- Feedstock for Petrochemical Plants: Natural gas can serve as a raw material for producing ammonia, hydrogen fuel, and materials like rubber, glass, steel, and paint.

Finally, incorporating gas utilization and flaring reduction technologies in the design of new oil developments can help operators avoid flaring at lower costs and reduce environmental impact.

Gas flaring can be avoided more easily than many other sources of greenhouse gas emissions. The gas currently being wasted could instead be put to productive use, reducing pollution while supporting energy needs. By applying effective technologies and stronger policies, the oil industry can transform flared gas from a source of harm into a source of opportunity.



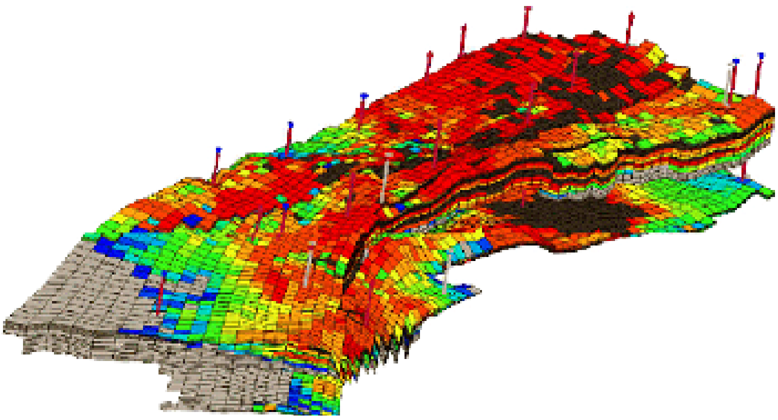


# RESERVOIR SIMULATION

## APPLICATIONS AND ADVANCES

Previously, we covered the first part of our topic, reservoir simulation. Our discussion of reservoir simulation fundamentals touched upon several important aspects, including the elements of a simulation study, the numerical approaches used in modern simulators, and the key components of reservoir simulation. In this section, we will explore the uses and applications of reservoir simulation, as well as its benefits.

Oil and gas companies use reservoir simulation models to develop new fields and to forecast production in existing fields, aiding investment decisions. Since building and maintaining a robust, reliable model is often time-consuming and expensive, models are typically constructed only when significant investment decisions are involved. Advances in simulation software now allow models to be developed more quickly and run on persopersonal computers, reducing the need for expensive workstations.



In the development of new fields, simulation models can help determine the number of wells required, the optimal well completions, artificial lift requirements, and expected production levels.

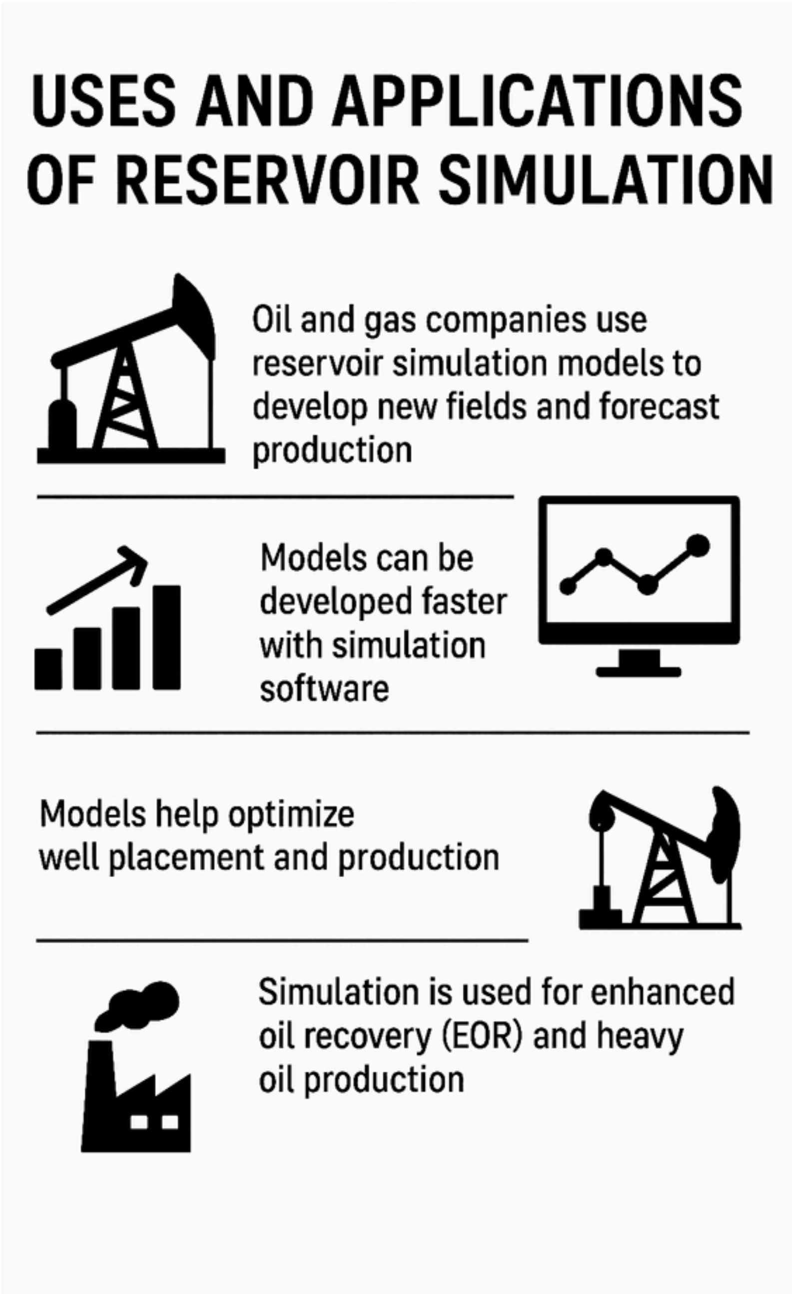
For ongoing reservoir management, models can assist in improving oil recovery through hydraulic fracturing, and they can represent horizontal or highly deviated wells. Hydraulic fracturing can be designed using specialized software, with resulting productivity improvements incorporated into the field model.

Simulations also help evaluate future improvements in oil recovery using pressure maintenance, such as reinjecting produced gas or injecting water into an aquifer. Reservoir simulations are commonly used to optimize water flooding strategies, improving oil displacement.

Enhanced oil recovery (EOR) requires certain field characteristics to be successful, and model studies can help evaluate these conditions. Various EOR processes are applied, such as miscible displacement using gases like carbon dioxide or nitrogen, and chemical flooding using polymers, alkalis, surfactants, or their combinations. These processes require specialized features in simulation software, and in some miscible applications, numerical dispersion (or "smearing" of the flood front) may pose challenges.

Reservoir simulation is also extensively used to increase oil production from heavy oil deposits. Steam or hot water injection lowers oil viscosity, improving recovery. There are two main steam-based techniques: steam flooding and steam soaks (where steam is injected into a well, then oil is produced). Accurate simulation of these processes requires accounting for heat transfer to the fluids, the formation, subsequent property changes, and heat losses outside the formation.

A recent application of reservoir simulation is modeling coal bed methane (CBM) production. CBM simulation requires specialized software and, in addition to standard fractured formation data, needs gas content at initial pressure, sorption isotherms, diffusion coefficients, and parameters to estimate changes in absolute permeability due to pore-pressure depletion and gas desorption.




# HYDROGEN

## The Fuel of the Future?


Hydrogen and energy have a long shared history. The first demonstrations of water electrolysis and fuel cells captured the imagination of engineers in the 1800s. Hydrogen was used to fuel the first internal combustion engines over 200 years ago. It provided lift to balloons and airships in the 18th and 19th centuries and propelled humanity to the moon in the 1960s. Hydrogen in ammonia fertilizer (from fossil fuels and, earlier, from electricity and water) has helped feed a growing global population. The produced hydrogen is used in producing ammonia fertilizer, which is an important crop nutrient.

### Reasons for Interest in Hydrogen:

- Clean energy / without pollution.
- Most abundant element in the universe.
- Lightest fuel.
- Richest in energy per unit mass.
- Can be produced from water.
- Allows direct conversion into thermal, mechanical, and electrical energy.

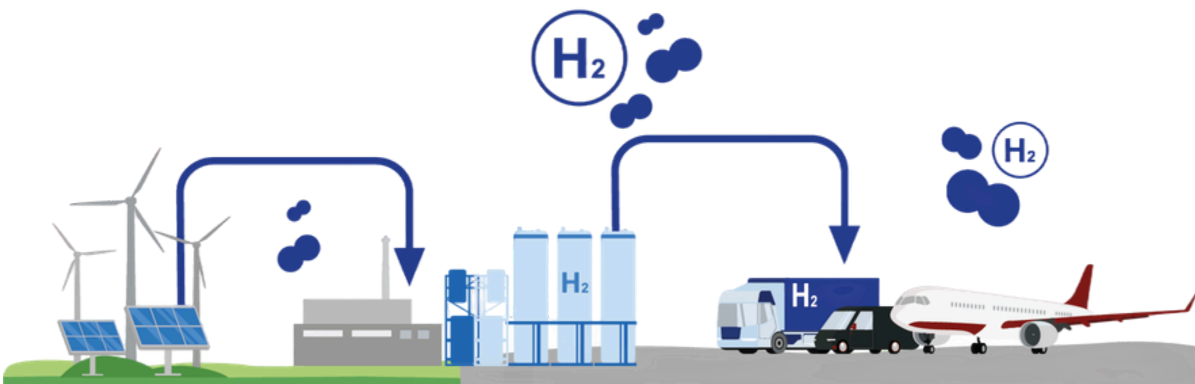
### What is Green Hydrogen, Blue Hydrogen, and So On?

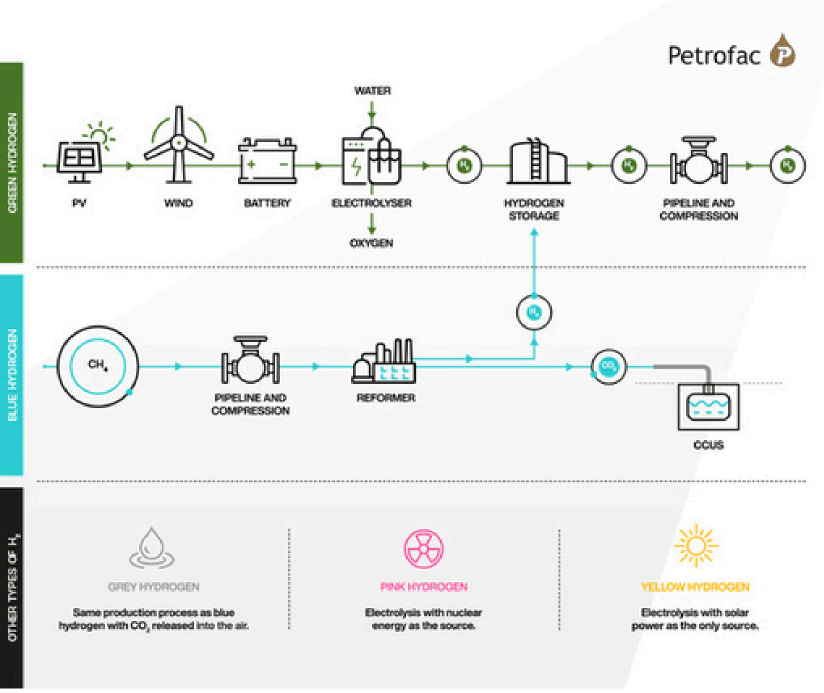
Producing hydrogen requires energy because hydrogen atoms don't exist on their own — they are almost always bound to another element. On Earth, hydrogen is particularly abundant in the form of water ($H_2O$). Creating pure hydrogen requires breaking those molecular bonds.

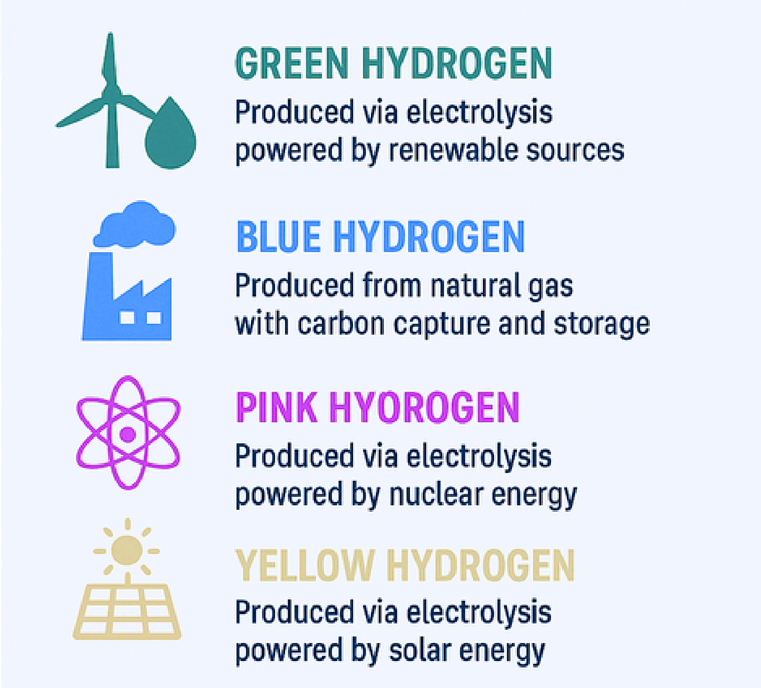
In the energy industry, hydrogen is often described by a range of "colors" as shorthand for how it was produced — such as blue, green, pink, or yellow. One method of producing hydrogen is a process called electrolysis, in which electricity is passed through water to split it into hydrogen and oxygen.

- Green hydrogen is produced when the electricity used for electrolysis comes from renewable sources like wind, water, or solar energy.

- Blue hydrogen is produced from natural gas through a process called steam methane reforming, where natural gas is mixed with very hot steam and a catalyst. A chemical reaction occurs, producing hydrogen and carbon monoxide. Water is then added, converting the carbon monoxide into carbon dioxide and more hydrogen. If the carbon dioxide emissions are captured and stored underground, the process is considered carbon-neutral, and the resulting hydrogen is called "blue hydrogen."








However, there is some controversy surrounding blue hydrogen because natural gas production inevitably results in methane emissions from so-called fugitive leaks — unintentional methane releases during drilling, extraction, and transportation. Although methane doesn't remain in the atmosphere as long as carbon dioxide, it is a far more potent greenhouse gas. Over 100 years, one ton of methane can be equivalent to 28–36 tons of carbon dioxide, according to the International Energy Agency (IEA).

- Pink hydrogen is similar to green hydrogen but produced via electrolysis powered by nuclear energy.
- Yellow hydrogen is another form made by electrolysis, but using only solar power (unlike green hydrogen, which may use a mix of renewable sources such as wind or solar).

## Is the Future Multi-Coloured?

The future of hydrogen is expected to transition from grey, through blue, to green hydrogen. What is clear is the important role hydrogen will play in the global energy transition.

Take the United Kingdom, one of Petrofac's key markets, as an example. The country's national energy system is evolving rapidly as it aims to reach its legally binding net-zero target by 2050. Although the UK is unlikely to produce sufficient quantities of green hydrogen to meet both targets and demand in the near term, we are likely to see a transition period of 20–30 years in which blue hydrogen plays a key role.

This is where the oil and gas industry, including Petrofac, can contribute by applying existing, transferable knowledge and capabilities to produce blue hydrogen through Carbon Capture, Utilisation, and Storage (CCUS). Existing UK offshore infrastructure can be used to transport $CO_2$ back to offshore reservoirs — either for Enhanced Oil Recovery (EOR) to maintain reservoir pressure, or into depleted reservoirs for safe, long-term storage.

To meet growing global energy demand while achieving national and international energy efficiency targets, the industry is exploring every possible technology. Both blue and green hydrogen have great potential and will play vital roles in the energy transition. With our experience and expertise, we are ready to support this transition.

As energy systems around the world continue to evolve, we are certain to hear much more about hydrogen in the years to come.

# REFERENCES


## THE ECONOMY AND THE OIL PRODUCING COUNTRIES

- TYPES OF ECONOMY: DEFINITION, TYPES & MORE | LEVERAGE EDU
- COUNTRIES MOST DEPENDENT ON OIL | STACKER)

## GAS FLARING: THE HIDDEN WASTE IN OIL PRODUCTION

- WHAT IS GAS FLAING WHY IS IT DO | GEERON
- GAS FLARING REDUCTION/GAS FLARING EXPLAINED | WORLDBANK
- TRACKING FLARING EMIS | IEA
- GAS FLARING IS A MAJOR,THE TWO MAJOR GREENHOUSE GASES | SCIRP

## HYDROGEN: THE FUEL OF THE FUTURE?

- IEA REPORT: FUTURE OF HYDROGEN
- PETROFAC
- HYDROGEN THE FUEL FOR 21ST CENTURY ,
- I.P. JAIN, 2009. SCIENCE DIRECT.



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